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ON THE
INFLUENCE OF THE SOLAR RADIATIONS
ON THE
VITAL POWERS OF PLANTS
GROWING UNDER
DIFFERENT ATMOSPHERIC CONDITIONS.

PART III.

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During the course of the experiments recorded in my last Report, a number of questions suggested themselves, and were incorporated in my remarks. To the solution of some of these I have since addressed myself.

In previously examining the germination and early growth of wheat and peas under the various coloured glasses and in obscurity, more or less complete, it was thought necessary not to cover the seeds with mould, since that would have greatly interfered with the quantity of the light that surrounded them. For certain reasons also the air was allowed to remain unchanged during the whole vegetation of the plants. A number of well-defined results were obtained; but they were liable to the objection that the wheat and peas were not grown under normal conditions. I have felt it to be the more necessary to remove this objection, seeing that one of the most important results arrived at was in direct antagonism to what other observers had remarked; the result was, that "the cutting off of the chemical ray facilitates in a marked manner the process of germination, and that both in reference to the protrusion of the radicle, and the evolution of the plume." During the spring of the present year, therefore, another series of experiments was instituted upon the growth of the same plants—wheat and peas—under the same coloured and obscured bell-glasses, with this important difference, that a little garden-mould was placed on the bricks, together with the seeds, but not in sufficient quantity to cover them from the light. The bricks were sunk in the earth of a small garden attached to my residence in London; the seeds were kept well-watered, and a slight change of air was permitted. The experiment was commenced on April 3. It was thought unnecessary in this instance to keep any record of the weather; suffice it to say, that the season was generally backward, and that cold east winds prevailed during the latter part of April, which interfered with the growth of the plants materially. Owing most probably to this circumstance, the experiments now detailed were not so successful as those of the previous year; the main results, therefore, will only be recorded.

In respect to the wheat, it began, as before, to germinate most speedily in obscurity, but of the coloured glasses the blue appeared to be the most favourable to its growth; the red light seemed also advantageous. On May 18th, when the experiment was put an end to, the best developed plants were found under the obscured colourless glass.

As to the peas, they also grew best and most rapidly in obscurity. Some circumstance militated against their proper development under the colourless and coloured glasses, with the single exception that the roots had been put forth well under the blue glass. On May 18th, it was found that in the dark all the peas experimented with had put forth long roots, and most of them had grown tall plants; while under the partially obscured colourless and partially obscured yellow glasses, all the peas had grown, giving plants, which for the most part were taller, more succulent and less healthy in colour than those which, having been planted at the same time, had grown in the garden without any covering. The peculiarly beneficial effect of the calorific ray on the growth of peas was not observed in this instance.

Notwithstanding the imperfect success of this series of experiments, they give support to the view generally entertained of the efficiency of the chemical ray in facilitating germination, which, however, my previous experiments (in accordance with those made by Dr. Daubeny) directly contradict.

The cause of this contrariety might naturally be sought for in the fact that there was soil about the seeds in this year's experiment. In hopes of determining this point, and as the season was not too far advanced, the following experiments were instituted.

Two sets of the large, colourless, blue and yellow bell-glasses were taken. The one set was placed over bricks in plates filled with water, and on the bricks were simply laid, in each instance, twelve grains of wheat and eight peas, previously weighed. They were placed in a sunny situation in the garden, and the air was occasionally changed. This set, therefore, was analogous to those described in the last Report. The other set was placed in a sunny part of the garden over spots where the same number of grains of wheat and of peas, also previously weighed, had been sown in the mould. They were watered, and the air was changed from time to time.

On May 26th, that is a few days after the commencement of the experiment, the wheat and peas had begun to burst under all the six glasses. Summer weather succeeded, warm sunshine and warm showers.

The wheat on the bricks appeared to germinate first under the blue glass, and it grew more quickly there, yet not so many had shown signs of life as under the other glasses, and in about a month's time it was found that the plants were growing about equally well under all the three shades, though somewhat impeded by the luxuriant growth of the peas. On July 19th the plants that had thriven were counted, measured, removed from the bricks, allowed to dry in the air for twenty-four hours, and then weighed.

	No. of plants.	Weight.	Average weight.	Average increase on original weight.	Average length of plants.
		grs.	grs.	grs.	inches.
Colourless	3	5·5	1·8	1·1	10
Blue	2	5·5	2·7	2	14
Yellow	4	8·5	2·1	1·4	13

The wheat that was sown in mould was found on May 30th to have grown to the height of two inches under the colourless and the yellow shades, but the plants were not so tall under the blue. Some of the wheat under the yellow was remarkably fine. On July 19th, the following were the observed results, the weight being taken as before:—

	Number of plants.	Weight.	Average weight.	Average increase in weight.	Average length of plants.
		grs.	grs.	grs.	inches.
Colourless	3	20·5	6·8	6·1	20
Blue	2	6	3	2·3	14
Yellow	4	31·5	7·9	7·2	23

It is worthy of remark, that whether with or without mould, the smallest number of wheat-seeds have germinated under the influence of the chemical ray; yet they appear to have grown well under these circumstances up to a certain point, but the plant seems to have required the luminous or the calorific rays in order to profit much by the soil.

The peas that were placed on the damp bricks were found on May 30th to have put forth radicles of half an inch or upwards in length under all the glasses, those under the blue being somewhat the longest. Presently the effect of the yellow light in causing the production of very long roots began to show itself. All the seeds germinated. On July 19th, the peas were treated as the wheat had been.

	Number of plants.	Weight.	Average weight.	Average increase of weight.	Average length of plant.
		grs.	grs.	grs.	inches.
Colourless	8	47	5·9	1·4	6
Blue	8	21·5	2·7	−1·8	9
Yellow	8	32	4	−0·5	7·5

The peas that were sown in mould began to grow equally at first, but in about three weeks' time those under the colourless glass were the shortest. They grew luxuriantly and filled the bell-glasses, but at the beginning of July the pea-plants which grew under the blue shade, and which had never thriven, shrivelled and died away. The leaves never opened properly. The following were the numerical observations made July 19th :—

	Number of plants.	Weight.	Average weight.	Average increase of weight.	Average length of plant.
		grs.	grs.	grs.	inches.
Colourless	8	98	12·2	7·7	33
Blue	...	...	......	...	...
Yellow	4	28	7	2·5	24

On comparing these last results, it is evident that whether with or without mould, the peas that grew under the blue glass display an inferiority. The peas growing in mould certainly produced the most healthy plants when they were exposed to all the influences of the solar ray, and the deprivation of the luminous principle proved fatal to them in their more mature growth, although the removal of the chemical ray had little effect.

These experiments indicate no relative difference in the actions of the three different coloured lights upon the germination of seeds, dependent on the absence or presence of soil; and they afford further confirmation of my former view, that the chemical rays rather militate against than favour the healthy germination of at least these particular instances of Monocotyledonous and Dicotyledonous plants. I remain unacquainted with the reason why the experiments of some other observers, and indeed one or two of my own, exhibit a tendency of seeds to germinate more readily under a blue glass. It may be from the more complete darkness thus produced ; but the problem is evidently a difficult and intricate one, and I abstain from further conjecture.

Among the queries at the close of the last Report was the following :— "Does carbonic acid act specifically in the prevention of germination, or merely by the exclusion of oxygen?" It was thought that this might be determined by substituting that gas for the nitrogen in the air, and observing whether seeds germinated equally well in such an atmosphere. Experiments previously recorded rendered it unnecessary for me to satisfy myself again that peas and wheat would commence growing in a colourless jar of twenty-five cubic inches capacity. Such a jar was therefore filled with a mixture of four parts of carbonic acid and one part of oxygen, placed over mercury, on the surface of which was a little water; it was placed in the garden with a sunny aspect. Mould was introduced, and some seeds of wheat and peas. After fourteen days it was found that the peas had merely split, and were black and decomposed, while the wheat showed no signs of germination, and were quite soft and decayed. An analogous experiment was made with pure oxygen gas. Both the peas and wheat germinated and grew a little, until no doubt the atmosphere of the jar was in a great measure converted into carbonic acid, when they also decayed. It appears then that carbonic acid in considerable excess has a positively injurious effect on germination.

In concluding the record of this investigation of the influence of solar radiations on the growth of plants under different atmospheric conditions, I feel very sensible of the imperfect nature of the results, and am convinced that such are the difficulties of the inquiry, that the conclusions actually arrived at must not be generalized without the greatest caution. Yet at the same time I beg to express the hope that other observers may take up some of the questions, to which I have incidentally alluded, but which still remain unanswered.